8. BELLSOUTH'S REQUIREMENTS

8.1 PSAP Requirement

At a minimum, 911 access through the wireless network should be transparent to both the mobile subscriber and PSAP. The call connection should be consistent in performance relative to wireline 911 calls.

These simple requirements have considerable impact on the wireless network, aside from the location technology alone. Also, there is impact on the PSAP, primarily in the type of information that is provided (e.g., the PSAP system must accept an ALI providing geographic data rather than street addresses). However, the choice of wireless location technology will be determined by its ability to achieve two fundamental objectives:

- Routing the emergency call to the appropriate PSAP, and
- Directing emergency response resources to the correct site.

In current wireline systems offering E 911, there is an intermediate 911 switching system or tandem between the wireline caller's central office and the PSAP. This switching system uses the caller's telephone number and a database to determine which PSAP should get the call. It also provides quick call transfers to other agencies and efficient concentration of dedicated lines or trunks from the area's central offices to an appropriate number of trunks that actually go to the PSAP. The use of an Automatic Number Identification (ANI) is the most common method for transferring the caller's telephone number to the PSAP. The ANI is used to point to a location database, the ALI/DMS. The ALI/DMS provides address and subscriber information to permit selective routing to the preferred PSAP, based upon political jurisdiction as well as central office boundaries.

Wireline E 911 services provide the PSAP with a street address and the telephone number of the caller. This provides the PSAP the ability to direct emergency response resources to the specific site from which the call originated if, indeed, the emergency is located at the call origination site. This data is typically available to the PSAP no later than five seconds after the 911 call has been received. As stated earlier, a wireless location technology is more likely to provide the PSAPs with geographic data rather than a street address. However, this geographic data will be required to offer something other than longitude and latitude. The location technology will need to map coordinates onto some recognizable database (i.e., street names and intersections, highways and mileage marker, etc.) and provide the PSAP with enough information to dispatch the emergency response team to the correct area.

Since PSAPs serve specific geographic areas that may overlap, but not necessarily map onto the wireless network, the ability to respond in a timely manner to an emergency call is highly dependent on routing the call to the proper PSAP. For the case of a cell or sector that exists within a single PSAP responsibility area, the location capability may be available today at this resolution. However, for cells/sectors at a PSAP border, a call that moves between PSAPs, or reflections that mask the true position of a subscriber, more sophisticated techniques may be required. Regardless of the location technology, sufficient caller location information for routing the 911 call to the appropriate PSAP should be available within, and not delay, the normal call processing interval. This interval can be of the order of two to five seconds. Longer delays to

the PSAP taking a wireless 911 call may be unacceptable. PSAP call takers will expect the same information delivery performance, regardless of the network from which the call originates. As the average duration of an emergency call is of the order of one minute, the wireless location technology should not impede this performance.

Emergency mobile radio subscriber callers may be either indoors or outdoors. The elements of information which accurately identify the caller's specific location can vary widely. Generally, indoor callers can be identified by a particular street address. However, this information does not usually state the specific area of the building such as floor or room. In large complexes, such as high rise or campuses, determining the caller's location can be substantially more difficult. As a result, therefore, precise location information will need to be provided in order to direct an emergency response team accurately to the site of the emergency. If the wireless 911 call originates from within a building, it is necessary to provide, at a minimum, a street address of that building. This implies that there will be a need to ensure there is an accurate mapping between wireline and wireless location databases. Indeed, at some point these two separate databases may be merged to form a single geo-file at a PSAP, or available centrally to all PSAPs.

In addition, due to the nature of a wireless 911 call, an outdoor caller's position may change during the duration of the call. As an example, a 911 call may originate outside of a building, but the caller may then enter some premises to arrive at the emergency site, seek shelter from the weather, etc. Likewise, the reverse scenario may take place. Therefore, the PSAP call taker will expect dynamic, real-time updating of the callers location.

Question 1. PSAP Routing Requirements

Respondents are asked to comment on the requirements for routing to the appropriate PSAP, and to provide specific information and/or comment on the following:

a) What are realistic expectations of location accuracy and time (to provide a reading) performance for a wireless location technology? Is accuracy dependent on time? When is the location information available?

b) What confidence factors could be attributed to the location data within the quoted time period? How does this factor vary with time?

c) Are the time constraints to route to the appropriate PSAP as posed above realistic? What issues will affect the time to deliver accurate location information?

Question 2. PSAP Emergency Response Requirements

Respondents are asked to comment on the following:

a) What are the issues surrounding the availability of sufficient location information to direct emergency response resources to the correct site.

b) What type of location information can be provided by a wireless technology (i.e., street intersections, highways, etc.)?

c) How could this location information be merged with a wireline location database? Who would be responsible for developing the "mapping"?

d) What type and/or accuracy of location information might be available within the timeframes of this RFI as stated in section 7.3.1?

Question 3. Dynamic location updating

The respondents are asked to provide their views on providing dynamic location/tracking information to the PSAP. Also, specifically, to provide information on the following:

a) Can the ability to track a subscriber whose location changes (indoors/outdoors) be accommodated? Will dynamic location information also be available?

b) What level of location resolution may be available on a periodic or continuous basis? What is the update interval?

c) How will the dynamic information be expected to be merged with the call? What data flow management information is necessary?

8.2 BellSouth Preferred Solution

BellSouth's solution has the following characteristics:

i) BellSouth's likely preferred solution is totally "network-centric" and has no requirement to modify the mobile subscriber's terminal in anyway. Alternatively, in a mobile subscriber terminal based solution the E911 location function is operationally user-transparent and is contained in a single integrated package.

ii) has clearly defined points for network interconnection or uses standard interfaces; therefore allows minimal operational interference during deployment and testing.

iii) has the ability to support several levels of network integration; therefore allows gradual migration towards total integration as the need arises or the business justifies.

iv) is location technology-independent as far as possible; to permit multi-mode and inter-network support for multiple location technology solutions.

v) incorporates a location technology that can be developed and enhanced into the future.

vi) provides or facilitates additional value-added services; therefore eases the business case for implementation.

Question 4. Characteristics of Preferred Solution

The list of characteristics given to describe BellSouth's preferred solution is by no means definitive. Respondents are invited to:

a) provide their view of the list.

b) comment on each of the characteristics.

c) provide an opinion on any additional ones that may enable clarification or provide completeness.

A straw-man, network-centric solution to wireless location is illustrated by Figure 8.1 below.

This approach may represent a possible Stage I implementation of wireless location capability to

the network. It should be noted that this is one of many possible solutions and is not meant to imply a specific implementation. However, many of the characteristics of the straw-man solution are consistent with BellSouth's preferred approach.

Referring to Figure 8.1, the location technology's acquisition station would co-reside with the wireless network's base station transceiver. The location information (initially; latitude, longitude and resolution) would be integrated with the message from the base station to base station controller and passed through to the mobile switch. The mobile switch recognizes the call as 911 and directs the message to a selective PSAP router. The router uses the location information to direct the call to the appropriate PSAP (there may be a number depending on network coverage) and, perhaps, redirect to a secondary PSAP if there is congestion at the primary. Once delivered to the PSAP, the location information (up until this time, only geographic coordinates) is used to determine a landmark-based identification of the emergency site that provides direction to the emergency response team. This "mapping" is derived from the automatic location information database available to the PSAPs.

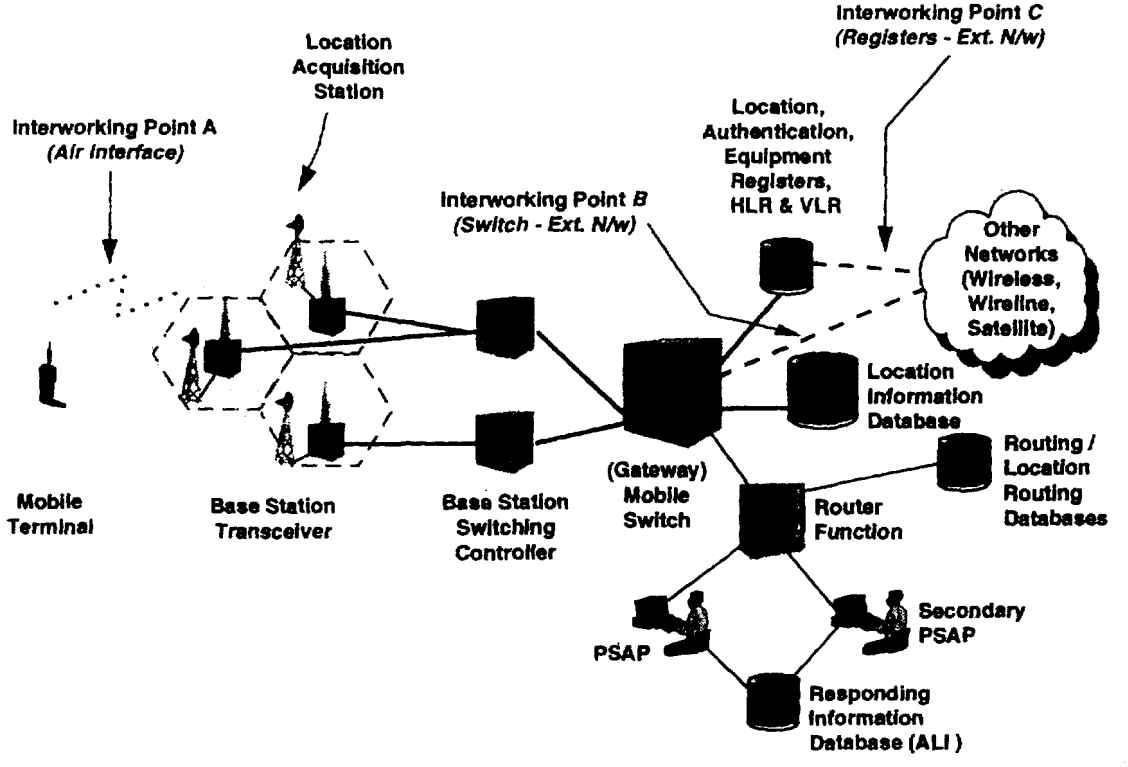

Figure 8.1 A Network-Centric Solution

In this example, the impact on the network has been minimized. There is no change to the subscriber terminal base and the location technology is assumed flexible enough to handle multiple air interfaces. Changes in the message used for setup and the mobile switch's software for routing to the PSAPs are expected. The router function and the routing/location routing databases represent new components of the network (aside from the location acquisition equipment) that may be managed by the wireless service provider.

Question 5. Network Centric Solution

Respondents are asked to give their views on the network centric, straw-man solution as outlined above. Specifically:

a) Is this solution consistent with the PSAP requirements as stated earlier?

b) Is the straw-man consistent with the characteristics outlined for the preferred solution?

c) Does a solution exist that may have less impact on the network? Would you suggest a different solution?

A strawman, mobile subscriber terminal (MST) based wireless location function is illustrated by Figure 8.2 below.

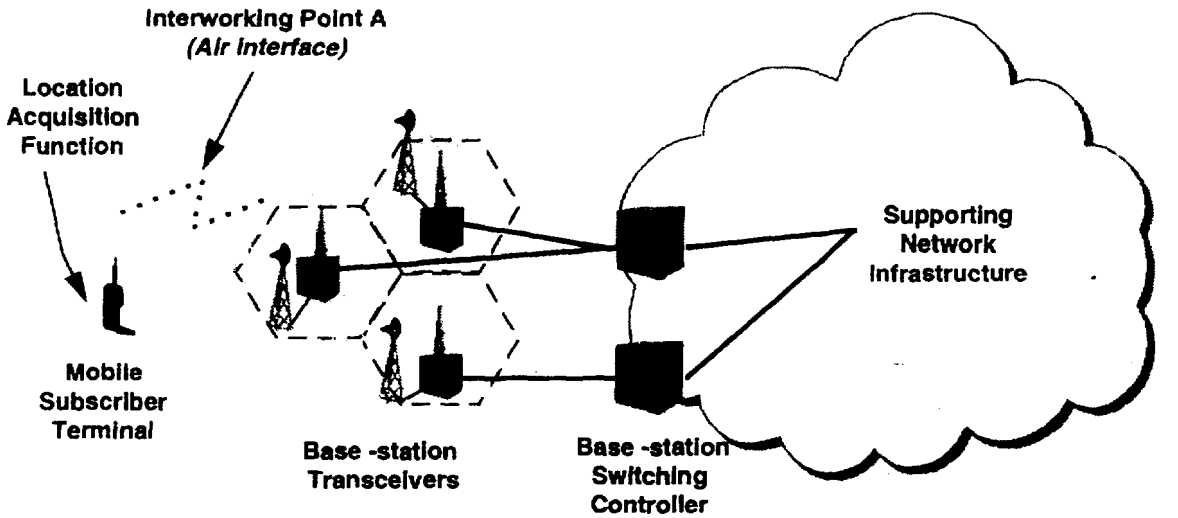

Figure 8.2 A Mobile Subscriber Terminal based Solution

In this example of an MST-based solution the radiolocation function is contained entirely within the terminal. The location information is transparent from the user and is integrated with information from the base-station to the switch controller on to the supporting wireless network infrastructure. The mobile switch recognizes the call as 911 and directs the call to the PSAP router. In much the same way as described in the above network-centric solution. Also, in this example, the air-interface is the only pre-determinant for roaming MST-based solutions; ie. any location technology can be integrated into the MST.

Question 6. Mobile Subscriber Terminal based Solution

Respondents are asked to give their views on this straw-man solution as outlined. Specifically:

a) Is the straw-man consistent with the characteristics outlined for BellSouth's preferred solution?

b) Does a solution exist that may have no impact on the network?

c) What are the advantages and disadvantages of an MST-based solution versus a network-centric one? Please elaborate, quantify or provide supporting information where possible.

d) What architectural changes are required to facilitate an MST-based solution (referencing Figures 8.1 and 8.2)?

8.2.1 Criteria

As stated above, there are several important characteristics that define BellSouth's preferred solution for providing wireless location. From this, there follows a clear set of criteria against which the selection of a location technology solution must be evaluated.

With approximately 30 million cellular subscribers, and growth rates that lead to a doubling of that number plus an anticipated 10 million PCS subscribers by the year 2000, ideally any initial implementation of a network-centric wireless location technology must work with this installed terminal base, if the actual benefit of 911 location capability is to be realized. For an MST-based implementation it is presumed that it can be offered as a product improvement and migrate through the installed base over the normal life-cycle/change-out timeline.

The rapid growth of commercial mobile radio services exists within an environment where the wireless communications technologies are also undergoing considerable development and change. New technologies, such as digital air-interfaces, are beginning to emerge in the marketplace and eventually will become the predominant commercial mobile radio service (CMRS) technologies. New services, such as PCS and improved performance cordless systems, will add to the product mix. Therefore, any location technology deployed, to the greatest extent possible, must be independent of the CMRS technologies that would co-exist.

The initial location technology to be deployed is likely to have a location accuracy which may not offer the ability to guide emergency personnel to the specific emergency site. Therefore, any technology chosen for location purposes must have the capability of improved performance over time (ie. location accuracy improvements over time, of say 500 ft to 40 ft). In other words, the location technology must not preclude this capability.

8.2.2 Network Integration

The requirement to deliver a wireless location technology which is independent of the installed terminal base forces the solution to center around the wireless communications network. The potential impact on the network can be illustrated through four levels of network integration:

- Integration Level 1

  Stand-alone location system (convergence with the wireless infrastructure at the database only). Hence, 0 % impact on the wireless system or may be an AIN function;

- Integration Level 2

  Overlay system that is minimally interlinked with wireless system (infrastructure, etc.) Requires reverse engineering of system interfaces to provide interlinking, shares towers, antennas, etc. Hence, < 20 % impact on the wireless system, possibly with AIN functionality;

- Integration Level 3

Moderate integration of overlay network, enabled by cooperation between infrastructure vendors and location determining technology suppliers. Hence, < 50 % impact on the wireless system;

- Integration Level 4

  Fully integrated with wireless system/networks requiring OEM system components from infrastructure vendors. Hence, up to 100 % impact on the wireless system.

Given the possible impact on network system elements of implementing a location technology, to support wireless emergency 911 services, it can be expected that a plan for gradual phasing-in of the technology would be developed. In order to support this, there will be a requirement for clearly defined points of interaction with the network. At these points, the interfaces will be defined to support the necessary standards essential to enable inter-network operation.

The plan for phasing-in the technology and its improving functionality should provide additional commercial benefits by enabling additional services as well as improved 911 support. This implementation or roll-out plan will also allow distribution of the cost of equipment and additional systems across the network over time. Important to choosing a location technology will be its ability to support incremental improvements without requiring major redundancy of components or throw away of system implementations. Correspondingly, the location technology system should have a clearly defined migration path to eventual full network integration. Once initially deployed, the hardware/software investment made in the location technology should serve as the foundation for eventual network improvements.

Question 7. Subscriber terminal criteria

Respondents are invited to give their views regarding this criteria, and to state any opposing rationale. Specifically, respondents are asked to address the following:

a) What would affect the viability of a first stage implementation limited to operation with the installed subscriber terminal base?

b) Would such an approach be compatible with the PSAP requirements outlined in section 8.1?

c) Under what circumstances would location system performance improvements dictate modification of the subscriber terminal?

d) What impact does an MST-based solution have on the terminal? Specifically, addressing cost, size, weight, battery life / talktime, and user-interface.

e) How will the impact on the MST by incorporating location capability alter the current trends in terminal evolution (lower cost, smaller size, multi-mode (air-interface), multi-frequency, multi-service capability (voice, data, image), etc.)?

f) Give your view of how the location capability can be implemented in the expected lifecycle of terminal product development.

g) Provide your view of how an MST equipped with location capability can be upgraded or enhanced to exploit improving location technology performance and functionality. In particular, how would you address the upgrading of a significant installed base of location-equipped MSTs created during continuous deployment and evolution?

Question 8. Multi-mode criteria

Respondents are invited to give their opinion of this criteria, and to state any opposing rationale. Specifically, respondents are asked to address the following:

a) What location technology would meet the requirements for the existing dual-mode systems of analog and digital technologies in use today, including digital systems employing digital control channels?

b) What combinations of multi-mode standards are likely to be supported in the timeframes of this RFI? Is one location technology suitable for all combinations? If not, which location technologies are likely to support each combination?

c) How viable is an implementation that provides location finding capability independent of the CMRS technology? What are the issues effecting such a capability?

d) In what timeframes would such a location technology exist? What needs to happen in order to facilitate its development, or change the timeframes?

e) What would be the benefits of deploying a CMRS technology-dependent location technology?

f) If CMRS technology-dependent, then which CMRS technology would be required? How would the location technology accommodate "roaming" subscribers?

Question 9. Location Accuracy criteria

Respondents are asked to provide information and commentary on this criteria by addressing the following:

a) What are the fundamental limitations affecting location accuracy with a particular location technology?

b) What are the issues affecting accuracy in a network-centric as opposed to a mobile radio subscriber terminal solution?

c) Which technologies, in your opinion, will best meet the needs of the criteria for improving accuracy over time? What are these projected improvements?

d) What will affect the dynamic availability of 'precise' location information to a PSAP, over the zero to ten seconds timeframe?

e) What other techniques might be used to improve the location information without over-burdening the location technology, such as supplementary or supporting databases, intelligent peripherals, etc.?

Question 10. Evolution and flexibility criteria

Respondents are invited to give their opinion of this criteria, and to state any opposing rationale. Specifically, respondents are asked to address the following:

a) What would be the impact of requiring improving location accuracy and performance? Over what time frames?

b) Which technologies would offer this capability?

c) Is it likely that a single technology would offer this flexibility?

d) Does the technology support incremental improvements and/or implementation? How; upgrade or change-out? What functionality is provided at each step?

e) What eventual redundancy might be expected, and at what cost?

Question 11. Network Integration

Respondents are invited to give their opinion of this view of network integration, and to state any opposing rationale. Specifically, respondents are asked to address the following:

a) Do you agree with the four levels of network integration outlined in Section 8.2.2 and the corresponding impact on the wireless system? If no, why?

b) Is there another way of addressing network integration that would provide a different view of the impact on the wireless system?

c) Is there a clear migration path to eventual full network integration? Upgrade, no throw-away parts?

Question 12. Network Migration

Respondents are invited to give their opinion of this criteria, and to state any opposing rationale. Specifically, respondents are asked to address the following:

a) Will the choice of a location technology preclude the migration from one level of integration to another? Is migration of benefit or essential to meet future requirements?

b) Is full network integration (such as Integration Level 4) a realistic goal? Under what conditions would full integration not be a reasonable approach?

c) What would a proposed migration path look like? What are the likely timescales?

d) What is the impact on the network of migration towards full integration? What parts of the network are likely to be affected by such upgrading?

e) Would the hardware and software used in the initial deployment of the location technology be disposed of or re-used?

Question 13. System costs

a) What are the location technology costs?

b) How does cost vary with functionality? Are there any cost breakpoints for performance?

c) Where in the network would the costs of a wireless location technology be distributed?

d) How would the distribution of these costs change as upgrades are made?

e) What types of maintenance costs for the location technology may exist? How may these change over time?

f) Will there be any additional communications network maintenance costs to support the location technology?

g) Although, proposals are not requested at this time, Respondents are invited to supply information on budgetary planning costs for several size deployments, such as might be expected throughout the US. These would include cellular systems for huge metropolises (ie. Los Angeles, CA), major cities (ie. Atlanta, GA), topographically variant sites (ie. Birmingham, AL), rural areas (ie. Tupelo-Corinth, MS (BTA #449)) and for PCS in an area such as Charlotte, NC.

Question 14. Additional commercial benefits

Respondents are invited to comment on or to provide information about additional services, value-added services or mechanisms by which additional commercial benefit might be accrued by leveraging location technology.

a) What value-added services would be enabled or enhanced by a wireless location technology?

b) How do these services depend on network vs. mobile subscriber location based capability ?

c) What market data do you have to support any new service opportunities?

d) What are the benefits, and in what timeframes would these benefits be available?

e) Would you be interested in participating in any such service provision? How?

f) Would providing these services have any impact on the cost, structure or operation of the network?

g) Would these services follow the same migration path as the 911 capability?

h) Would additional value-added services have any impact on the 911 capability? Would providing these services have any impact on the time to deliver a wireless 911 capability?

9. LOCATION TECHNOLOGY SOLUTIONS

9.1 Impact on Wireless Network

Due to the nature of wireless communications the deployment of any location function will have an impact on the wireless network. As discussed earlier, a location technology can be integrated into the CMRS network at various levels. Integration can be viewed as a two dimensional continuum with several possible solutions with many discrete levels of integration.

One dimension reflects the impact on the mobile subscriber terminal (MST), and the other reflects increasing network integration. Figure 9.1 illustrates some possible solutions. Examples range from stand-alone (no wireless network inter-connection) location systems, that may only converge with the telecommunications network at the PSAP database, to fully integrated systems whereby the location technology is an integral part of the network (mobile radio subscriber terminal and/or network interconnections). In the extreme it could be expected that multiple locations systems could be accommodated, if the network interconnections /interfaces are standardized and the network controls the access to location data from the embedded location technology in the mobile radio subscriber terminal, base station or cell site controller.

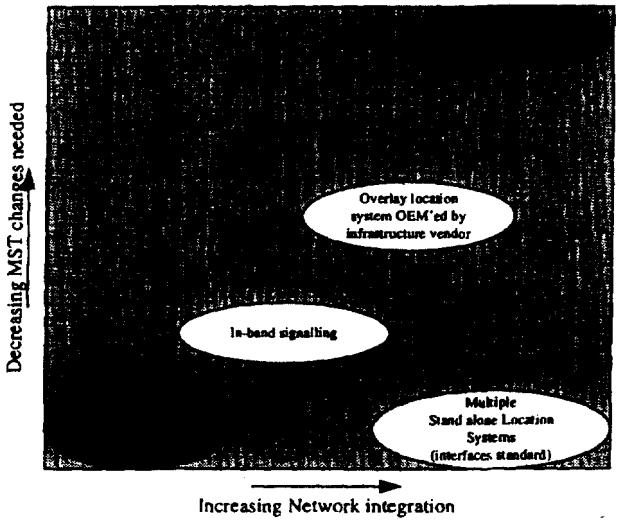

Figure 9.1: Spectrum of Network Integration

Regardless of the level of network integration, there are several key issues that must be addressed by any location technology solution:

i) Availability of location data

ii) Network interconnection

iii) Impact on network architecture

iv) Inter-system performance (wireless and location systems)

v) Implementation and future migration

Question 15. Impact on the Wireless Network

Respondents are invited to discuss their views on the issues that affect the impact on the wireless network. Respondents should provide comment on the relative importance of the above issues.

In addition, they are asked to provide information on the following particular issues.

Question 16. Accuracy and Availability of Location information

a) How does the location system recognize a 911 call, or initiate a 911 location function?

b) What is the form of the location data?

c) What is the timing and availability of location information once a 911 call has been initiated? Is it on-demand or continually available?

d) Can non-911 calls be included?

e) Can the location of a mobile subscriber terminal be determined for a land initiated call (such as for a 911 PSAP call back)?

Question 17. Network Interconnection

a) How is location information acquired and transferred into the wireless network?

b) What wireless network interfaces are required?

c) What other infrastructure interconnections are necessary?

d) How is transfer and hand-off between base stations, cell sites and different networks possible?

e) If the proposed location system is an "overlay", what additional equipment is required?

Question 18. Impact on Network Architecture

a) If one considers the four levels of integration as described in section 8.2.2, how do these issues change relative to their importance/priority for each level?

b) How are the data flows managed, for synchronizing or mapping location information with a corresponding call?

c) How will the various cellular and PCS architectures/configurations be supported by the location technology, such as macro, micro and pico-cells; hierarchical and overlay networks; distributed antenna systems (ie. in-tunnel systems, in-building, wireless local loop access, etc.); cell repeaters, enhancers and transcoders; 3-dimensional cell structures for high rise buildings; etc.?

d) What are the requirements for network signaling?

e) Can these be addressed by existing or additional AIN or intelligent peripheral functionality?

f) Are there other issues that may have the same or more influence on the network architecture?

Question 19. Inter-system Performance

a) What, if any, is the impact of channel coding and wireless network signaling security?

b) Is any system interference probable?

c) Are there any performance limitations due to power control and the signal to noise ratios encountered in wireless systems?

d) What is the impact of high speed hand-offs on the determination of location? What is the impact on hand-off through multiple cells, base stations, base station controllers, etc.?

Question 20. Implementation and Future migration

a) Is any network or infrastructure equipment and systems sharing possible? With cellular, PCS or other wireless networks - Respondents should specify which networks and how?

b) If the location technology proposed is an inherent part of the wireless network's radio infrastructure, what system elements (antennas, towers, radio transceivers, interconnections systems, etc.) will be affected?

c) What is the development status of any common elements needed for an integrated solution with the respective manufacturers of those sub-systems? What is the potential availability?

d) What testing has been undertaken (either as an overlay or integrated system)?

e) Are there any implications for implementation? What are the phases of implementation?

f) What is the potential for future migration and inclusion of enhancements?

g) What are the location technology costs, and how are these distributed over the network?

Question 21. System Integration

Respondents should discuss whether a fully integrated system is the best and ultimate solution.

In addition, referring the levels of integration discussed in section 8.2.2 respondents should consider the following for their location technology or proposed solution:

a) Is it feasible to expect to migrate from one level of integration to another?

b) Do new issues arise as one migrates from one level of integration to another?

c) Is there another level of integration which offers better flexibility and performance?

d) What is your preferred level of integration?

e) What would be a feasible migration path for implementing a wireless location technology solution today to the eventual preferred level of integration?

Question 22. Standards

Respondents are invited to comment on the impact of standards needed to implement the various levels of integration discussed previously.

a) Which standards will be effected?

b) How will these standards be best addressed? By which bodies or fora?

c) Are you willing to participate or sponsor any particular standard or working group?

d) Are you willing to have your technology become a standard? What licensing arrangements would you consider?

e) Is there any activity today that could potentially inhibit or delay the deployment of a wireless location system?

f) What are your views about creating an 'industry test-bed' for evaluating wireless location systems? What form would you prefer such a test-bed take?

9.2 Technology Requirements

The previous discussion has focused on the potential impact of any wireless location technology on the wireless communications network. From this, a number of specific issues can be identified that will affect the eventual choice of location technology. These include:

- accuracy
- timing and availability
- confidence and reliability
- scalability for dense urban and rural coverage
- in-building and varying outdoor environment (ie. Over water, etc.) performance
- mobility performance
- standards/multi-mode compatibility

Figure 9.2 below views a slice of the previously described integration continuum; in this example, that of a stand-alone network. In this way, the issues above can be mapped against that slice based on developmental maturity. In fact, we may see that there are several levels of maturity that are based on some development timeframe (one and three years as in the illustration).

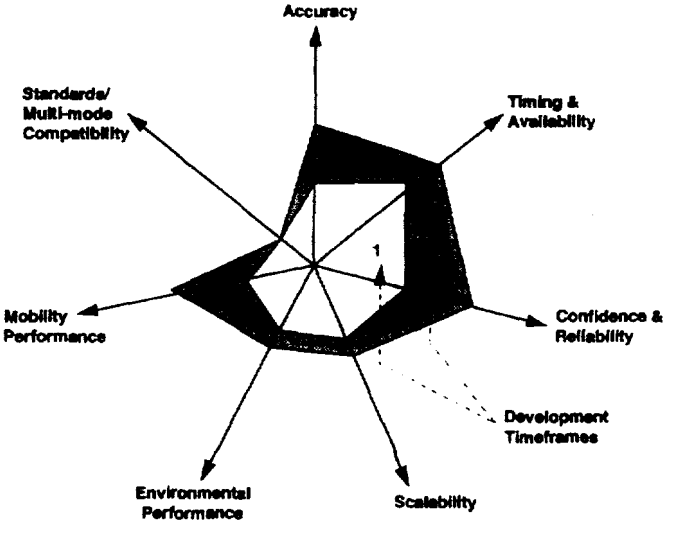

Figure 9.2 Technology/Performance Issues Map

Referring to Figure 9.2, a first year implementation may provide relatively reasonable performance along the lines of accuracy, reliability and scalability, with reduced performance on environmental, mobility and multi-mode capability. Improvements to the technology, in a three year timeframe, would concentrate on the system's accuracy, reliability and mobility performance. Improvements in multi-mode compatibility may not be realizable by the location technology after the initial deployment.

The value of this illustration is to understand the potential trade-offs that will be required, from a systems performance perspective, when deploying any wireless location technology. It is expected that no single technology will provide full performance capabilities over a short period of time. Therefore, which areas of performance are achievable and what the focus of future developments is, will be key to selecting a location technology.

Question 23. Proposed Location Technology

Respondents are asked to provide information on the state of the wireless location technology they are offering, or would propose. Specifically, they are asked to outline their solution for providing emergency 911 wireless access.

In addition to the above information, please include responses to the following questions:

Question 24. Accuracy, Timing and Availability

a) How would you define location accuracy for your location determining technology? How is it expressed (statistically, rms, % error, circular error probability, etc.). Please supply examples.

b) What is the accuracy of location of the technology? What will affect the accuracy deviation?

c) How is accuracy dependent on time (0 - 10 seconds, and beyond)?

d) When is stable location information available?

e) Is location accuracy updatable? Dynamic update possible? What is the update period?

f) Is tracking possible? How does tracking capability impact the system (such as performance over time, etc.) What additional system components are required for this capability?

Question 25. Confidence and Reliability

a) What is the confidence factor attributed to the location data within the quoted time period for your technology? How does this factor vary with time?

b) How does the accuracy and repeatability vary for different environments and state how the technology is influenced by external variables, such as multiple cell sites in city or rural areas, single cell configurations, multipath, hilly terrain, dense or urban areas, etc.?

c) Will the accuracy or performance of the location technology depend on any elements of the wireless network, such as databases, the HLR or VLR? If so, what provision is expected to ensure consistency of information, particularly as the caller roams?

d) What provision does your technology offer for redundancy, fail-safe or failure recovery? What mechanisms are provided for system monitoring?

Question 26. Coverage

a) Describe the capability of your system to provide location coverage in both sparsely populated rural areas as well as dense urban environments.

b) Can your technology offer both in-building and outside location ability? Does this capability provide tracking of a caller from inside to outside, and vice versa?

c) How does the performance of the system change with varying outdoor (environmental) conditions?

d) How does the performance vary in a fixed or mobile highway environment? Stationary, low speed vs. high speed?

e) Comment on the impact on performance of your technology if the MST is contained in a persons pocket, in a purse or briefcase, or left laying on a seat in a vehicle. Include in your consideration the impact on handsfree capability, time to obtain initial location fix and location data acquisition on PSAP call back.

f) How does the performance of the system behave with varying 911 traffic conditions? What limitations might you expect?

Question 27. Standards/Multi-mode Capability

a) Which standards, current and in developing, most affect your system?

b) Does your technology offer multi-mode compatibility? Which combinations?

c) If not, when, ever? What CMRS technology does your system currently support?

Question 28. Implementation

a) With regard to the wireless location technology you offer, what is the development status of the technology, particularly relative to each of the issues cited in section 9.1?

b) What other important network architecture issues does your technology address that were not cited previously?

c) What enabling technology developments are required to support your system? Who is developing them? What is their timing?

d) What are the critical supporting technologies that must exist in the network to enable your technology?

e) Using a chart such as that illustrated in Figure 9.2, map planned or expected developments over time. (Use a consistent scale of your choosing; however, please include an explanation.)

f) Which areas of performance are considered important for future developments? Which do you consider key to selecting a location technology?

g) If possible, describe the potential evolution path of your technology including improving performance over time.

h) What trials, system testing have been undertaken? Are results available?

i) What trials or testing have been undertaken in conjunction with a CMRS developer, service provider or network? Are results available? What further testing is planned?

j) What other potential commercial benefits can your technology offer, or what other services will it enable?

9.3 Timing

As has been discussed, the commercial maturity of many wireless location technologies may be such that development will be required before realization of the "best" integrated solution. In fact, it may be necessary to begin implementation as a stand-alone system with the eventual goal of more robust integration with the network.

Question 29. Technology Timelines

a) What is the development status of the technology that you currently offer?

b) How and when do you expect location accuracy to improve in the future?

c) What development is required to realize your preferred level of integration?

d) What is the timeframe for achieving that level of integration?

e) What critical supporting developments are required to facilitate the implementation of your technology (e.g., air-interfaces, standards, base stations, antennas, etc.)?

f) What are the timelines relative to these supporting technologies? Who is developing these technologies?

g) What is the migration path from where your technology is today to your preferred level of integration?

9.4 Alternative Solutions

As BellSouth's preferred solution, the focus of this discussion has been on network centric wireless location technologies. However, technology developments continue to progress in other areas (e.g., GPS, or IVHS technologies) which may eventually offer higher or different levels of performance and flexibility. Indeed, with ability to provide added commercial benefit and value-added services, there may exist a compelling strategy for migrating from an interim network-centric solution to an alternative solution.

Question 30. Alternative solutions

a) What other technologies exist that can provide a wireless location capability?

b) What is the current development status of these technologies? Who is developing them?

c) How do these technologies address each of the network impact issues described earlier?

d) What will be the major impact on the network (i.e., mobile terminals, base stations, switches, etc.) of an alternative solution? What is required of the network to support an alternative location technology solution?

e) What level of integration are alternative solutions capable of addressing now?

f) What is the most probable/preferred level of integration as a future solution? What is the migration path to this preferred level of integration?

g) What supporting technologies/systems are required to incorporate these alternative location technologies in a wireless E911 application? What is the status of their development? Who is developing these technologies?

h) Can alternative solutions co-exist with network-based solutions?

Question 31. Alternative solution benefits

Respondents are asked to comment on the above (alternative solutions). They should also consider the following:

a) What is a likely migration strategy from one technology to another.

b) Is there any benefit to multiple technology solutions?

c) What would the impact of multiple technologies be on the network?

d) What other services or commercial benefits can these alternative technologies support or enable?

9.5 Secondary System Considerations

If a location technology is deployed to provide E911 emergency wireless access, there are several other related scenarios that will need to be considered. Although these scenarios may not be the driving force behind the need for implementing a location technology, some of them are under consideration currently, and as such may loosely influence the feasibility of deploying E 911 wireless access.

Three example scenarios, in particular are included for consideration by the industry:

- What will be the impact of providing E911 access to service-initiated, but currently out-of-service mobile terminals? These terminals will require access to emergency 911 service via networks other than the original service provider's (for example, a subscriber may have moved out of the network to which they originally subscribed to reside within the coverage of another provider's network to which they have no service entitlement).
- Progress in radio technology is such that cordless terminals are emerging with range capabilities rivaling that of commercial mobile radio services (CMRS). Using the PCS model, there could be significant convergence of services in the form of wireless local loop access, where a cordless subscriber terminal behaves like a "fixed" location wireless/CMRS mobile subscriber terminal. The location of an emergency 911 caller using one of these cordless terminals could potentially be far outside the location accuracy requirements of the 911 emergency service providers.
- As a corollary to the emerging cordless range capability, in the PCS model for example, CMRS subscriber terminals can legitimately provide "fixed" location wireless service access. Such a use could ease the requirements on the location technology provided the wireless network had the inherent intelligence to detect this particular mode of operation, or the serving base station is able to behave like a wireline service counterpart.

BellSouth is particularly interested in receiving information related to how these scenarios might be addressed and/or influence the choice of location technology.

Question 32. Other Service Considerations

Respondents are invited to give their views on the issues raised by the examples outlined.

a) Are there other such examples?

b) How important are these examples? Can the issues raised be ignored? When will they need to be addressed?

Question 33. Implementation

Respondents are asked to comment on the possible inclusion of the examples in any implementation of location technology.

a) What would be their impact on the choice of technology?

b) Would they change the technology or network requirements with any significance?

c) How might they be included? Short term versus later inclusion?

10. CHECKLIST OF RFI QUESTIONS

Q #	*Section Number*	*Question*	*Answered (✓/✗)*
1.	*8.1*	***PSAP Routing Requirements*** Respondents are asked to comment on the requirements for routing to the appropriate PSAP, and to provide specific information and/or comment on the following: a) What are realistic expectations of location accuracy and time (to provide a reading) performance for a wireless location technology? Is accuracy dependent on time? When is the location information available? b) What confidence factors could be attributed to the location data within the quoted time period? How does this factor vary with time? *c)* Are the time constraints to route to the appropriate PSAP as posed above realistic? What issues will affect the time to deliver accurate location information?	
2.		***PSAP Emergency Response Requirements*** Respondents are asked to comment on the following: a) What are the issues surrounding the availability of sufficient location information to direct emergency response resources to the correct site. b) What type of location information can be provided by a wireless technology (i.e., street intersections, highways, etc.)? c) How could this location information be merged with a wireline location database? Who would be responsible for developing the "mapping"? d) What type and/or accuracy of location information might be available within the timeframes of this RFI as stated in section 7.3.1?	
3.	*(cont.)*	***Dynamic location updating*** The respondents are asked to provide their views on providing dynamic location/tracking information to the PSAP. Also, specifically, to provide information on the following: b) Can the ability to track a subscriber whose location changes (indoors/outdoors) be accommodated? Will dynamic location information also be available? c) What level of location resolution may be available on a periodic or continuous basis? What is the update interval?	

Q #	Section Number	Question	Answered (✓/✗)
	(cont.)	d) How will the dynamic information be expected to be merged with the call? What data flow management information is necessary?	
4.	8.2	***Characteristics of Preferred Solution*** The list of characteristics given to describe BellSouth's preferred solution is by no means definitive. Respondents are invited to: a) provide their view of the list. b) comment on each of the characteristics. c) provide an opinion on any additional ones that may enable clarification or provide completeness.	
5.		***Network Centric Solution*** Respondents are asked to give their views on the network centric, straw-man solution as outlined above. Specifically: a) Is this solution consistent with the PSAP requirements as stated earlier? b) Is the straw-man consistent with the characteristics outlined for the preferred solution? c) Does a solution exist that may have less impact on the network? Would you suggest a different solution?	
6.		***Mobile Subscriber Terminal based Solution*** Respondents are asked to give their views on this straw-man solution as outlined. Specifically: a) Is the straw-man consistent with the characteristics outlined for BellSouth's preferred solution? b) Does a solution exist that may have no impact on the network? c) What are the advantages and disadvantages of an MST-based solution versus a network-centric one? Please elaborate, quantify or provide supporting information where possible. *d)* What architectural changes are required to facilitate an MST-based solution (referencing Figures 8.1 and 8.2)?	
7.	8.2 *(cont.)*	***Subscriber terminal criteria*** Respondents are invited to give their views regarding this criteria, and to state any opposing rationale. Specifically, respondents are asked to address the following: *a)* What would affect the viability of a first stage implementation limited to operation with the installed subscriber terminal base?	

Q #	*Section Number*	*Question*	*Answered (✓/✗)*
	(cont.)	b) Would such an approach be compatible with the PSAP requirements outlined in section 8.1? c) Under what circumstances would location system performance improvements dictate modification of the subscriber terminal? d) What impact does an MST-based solution have on the terminal? Specifically, addressing cost, size, weight, battery life / talktime, and user-interface. e) How will the impact on the MST by incorporating location capability alter the current trends in terminal evolution (lower cost, smaller size, multi-mode (air-interface), multi-frequency, multi-service capability (voice, data, image), etc.)? f) Give your view of how the location capability can be implemented in the expected lifecycle of terminal product development. g) Provide your view of how an MST equipped with location capability can be upgraded or enhanced to exploit improving location technology performance and functionality. In particular, how would you address the upgrading of a significant installed base of location-equipped MSTs created during continuous deployment and evolution?	
8.	*(cont.*	***Multi-mode criteria*** Respondents are invited to give their opinion of this criteria, and to state any opposing rationale. Specifically, respondents are asked to address the following: a) What location technology would meet the requirements for the existing dual-mode systems of analog and digital technologies in use today, including digital systems employing digital control channels? b) What combinations of multi-mode standards are likely to be supported in the timeframes of this RFI? Is one location technology suitable for all combinations? If not, which location technologies are likely to support each combination? c) How viable is an implementation that provides location finding capability independent of the CMRS technology? What are the issues effecting such a capability? d) In what timeframes would such a location technology exist? What needs to happen in order to facilitate its development, or change the timeframes? e) What would be the benefits of deploying a CMRS technology-	

Q #	Section Number	Question	Answered (✓/✗)
		dependent location technology? f) If CMRS technology-dependent, then which CMRS technology would be required? How would the location technology accommodate "roaming" subscribers?	
9.		***Location Accuracy criteria*** Respondents are asked to provide information and commentary on this criteria by addressing the following: a) What are the fundamental limitations affecting location accuracy with a particular location technology? b) What are the issues affecting accuracy in a network-centric as opposed to a mobile radio subscriber terminal solution? c) Which technologies, in your opinion, will best meet the needs of the criteria for improving accuracy over time? What are these projected improvements? d) What will affect the dynamic availability of 'precise' location information to a PSAP, over the zero to ten seconds timeframe? e) What techniques might be used to improve the location information without over-burdening the location technology, such as supplementary or supporting databases, intelligent peripherals, etc.?	
10.		***Evolution and flexibility criteria*** Respondents are invited to give their opinion of this criteria, and to state any opposing rationale. Specifically, respondents are asked to address the following: a) What would be the impact of requiring improving location accuracy and performance? Over what time frames? b) Which technologies would offer this capability? c) Is it likely that a single technology would offer this flexibility? d) Does the technology support incremental improvements and/or implementation? How; upgrade or change-out? What functionality is provided at each step? e) What eventual redundancy might be expected, and at what cost?	
11.	*(cont.)*	***Network Integration*** Respondents are invited to give their opinion of this view of network integration, and to state any opposing rationale. Specifically, respondents are asked to address the following: a) Do you agree with the four levels of network integration outlined in Section 8.2.2 and the corresponding impact on the wireless system?	

Q #	*Section Number*	*Question*	*Answered (✓/✗)*
	(cont.)	If no, why? b) Is there another way of addressing network integration that would provide a different view of the impact on the wireless system? c) Is there a clear migration path to eventual full network integration? Upgrade, no throw-away parts?	
12.		***Network Migration*** Respondents are invited to give their opinion of this criteria, and to state any opposing rationale. Specifically, respondents are asked to address the following: a) Will the choice of a location technology preclude the migration from one level of integration to another? Is migration of benefit or essential to meet future requirements? b) Is full network integration (such as Integration Level 4) a realistic goal? Under what conditions would full integration not be a reasonable approach? c) What would a proposed migration path look like? What are the likely timescales? d) What is the impact on the network of migration towards full integration? What parts of the network are likely to be affected by such upgrading? e) Would the hardware and software used in the initial deployment of the location technology be disposed of or re-used?	
13.	*(cont.)*	***System costs*** a) What are the location technology costs? b) How does cost vary with functionality? Are there any cost breakpoints for performance? c) Where in the network would the costs of a wireless location technology be distributed? d) How would the distribution of these costs change as upgrades are made? e) What types of maintenance costs for the location technology may exist? How may these change over time? f) Will there be any additional communications network maintenance costs to support the location technology? g) Although, proposals are not requested at this time, Respondents are invited to supply information on budgetary planning costs for several size deployments, such as might be expected throughout the US. These would include cellular systems for huge metropolises	

Q #	Section Number	Question	Answered (✓/x)
	(cont.)	(ie. Los Angeles, CA), major cities (ie. Atlanta, GA), topographically variant sites (ie. Birmingham, AL), rural areas (ie. Tupelo-Corinth, MS (BTA #449)) and for PCS in an area such as Charlotte, NC.	
14.		***Additional commercial benefits*** Respondents are invited to comment on or to provide information about additional services, value-added services or mechanisms by which additional commercial benefit might be accrued by leveraging location technology. a) What value-added services would be enabled or enhanced by a wireless location technology? b) How do these services depend on network vs. mobile subscriber location based capability ? c) What market data do you have to support any new service opportunities? d) What are the benefits, and in what timeframes would these benefits be available? e) Would you be interested in participating in any such service provision? How? f) Would providing these services have any impact on the cost, structure or operation of the network? g) Would these services follow the same migration path as the 911 capability? h) Would additional value-added services have any impact on the 911 capability? Would providing these services have any impact on the time to deliver a wireless 911 capability?	
15.	*9.1*	***Impact on the Network*** Respondents are invited to discuss their views on the issues that affect the impact on the wireless network. Respondents should provide comment on the relative importance of the above issues. In addition, they are asked to provide information on the following particular issues.	
16.	*(cont.)*	***Accuracy and Availability of Location information*** a) How does the location system recognize a 911 call, or initiate a 911 location function? b) What is the form of the location data?	

Q #	*Section Number*	*Question*	*Answered (✓/✗)*
	(cont.)	c) What is the timing and availability of location information once a 911 call has been initiated? Is it on-demand or continually available? d) Can non-911 calls be included? e) Can the location of a mobile subscriber terminal be determined for a land initiated call (such as for a 911 PSAP call back)?	
17.		***Network Interconnection*** a) How is location information acquired and transferred into the wireless network? b) What wireless network interfaces are required? c) What other infrastructure interconnections are necessary? d) How is transfer and hand-off between base stations, cell sites and different networks possible? e) If the proposed location system is an "overlay", what additional equipment is required?	
18.		***Impact on Network Architecture*** a) If one considers the four levels of integration as described in section 8.2.2, how do these issues change relative to their importance/priority for each level? b) How are the data flows managed, for synchronizing or mapping location information with a corresponding call? c) How will the various cellular and PCS architectures/configurations be supported by the location technology, such as macro, micro and pico-cells; hierarchical and overlay networks; distributed antenna systems (ie. in-tunnel systems, in-building, wireless local loop access, etc.); cell repeaters, enhancers and transcoders; 3-dimensional cell structures for high rise buildings; etc.? d) What are the requirements for network signaling? e) Can these be addressed by existing or additional AIN or intelligent peripheral functionality? f) Are there other issues that may have the same or more influence on the network architecture?	
19.	*(cont.)*	***Inter-system Performance*** a) What, if any, is the impact of channel coding and wireless network signaling security? b) Is any system interference probable?	

Q #	Section Number	Question	Answered (✓/✗)
	(cont.)	c) Are there any performance limitations due to power control and the signal to noise ratios encountered in wireless systems? d) What is the impact of high speed hand-offs on the determination of location? What is the impact on hand-off through multiple cells, base stations, base station controllers, etc.?	
20.		***Implementation and Future migration*** a) Is any network or infrastructure equipment and systems sharing possible? With cellular, PCS or other wireless networks - Respondents should specify which networks and how? b) If the location technology proposed is an inherent part of the wireless network's radio infrastructure, what system elements (antennas, towers, radio transceivers, interconnections systems, etc.) will be affected? c) What is the development status of any common elements needed for an integrated solution with the respective manufacturers of those sub-systems? What is the potential availability? d) What testing has been undertaken (either as an overlay or integrated system)? e) Are there any implications for implementation? What are the phases of implementation? f) What is the potential for future migration and inclusion of enhancements? g) What are the location technology costs, and how are these distributed over the network?	
21.	*(cont.)*	***System Integration*** Respondents should discuss whether a fully integrated system is the best and ultimate solution. In addition, referring the levels of integration discussed in section 8.2.2 respondents should consider the following for their location technology or proposed solution: a) Is it feasible to expect to migrate from one level of integration to another? b) Do new issues arise as one migrates from one level of integration to another? c) Is there another level of integration which offers better flexibility and performance? d) What is your preferred level of integration?	

Q #	Section Number	Question	Answered (✓/✗)
	(cont.)	e) What would be a feasible migration path for implementing a wireless location technology solution today to the eventual preferred level of integration?	
22.		***Standards*** Respondents are invited to comment on the impact of standards needed to implement the various levels of integration discussed previously. a) Which standards will be effected? b) How will these standards be best addressed? By which bodies or fora? c) Are you willing to participate or sponsor any particular standard or working group? d) Are you willing to have your technology become a standard? What licensing arrangements would you consider? e) Is there any activity today that could potentially inhibit or delay the deployment of a wireless location system? f) What are your views about creating an 'industry test-bed' for evaluating wireless location systems? What form would you prefer such a test-bed take?	
23.	9.2	***Proposed Location Technology*** Respondents are asked to provide information on the state of the wireless location technology they are offering, or would propose. Specifically, they are asked to outline their solution for providing emergency 911 wireless access. In addition to the above information, please include responses to the following questions:	
24.	*(cont.)*	***Accuracy, Timing and Availability*** a) How would you define location accuracy for your location determining technology? How is it expressed (statistically, rms, % error, circular error probability, etc.). Please supply examples. b) What is the accuracy of location of the technology? What will affect the accuracy deviation? c) How is accuracy dependent on time (0 - 10 seconds, and beyond)? d) When is stable location information available? e) Is location accuracy updatable? Dynamic update possible? What is the update period?	

Q #	*Section Number*	*Question*	*Answered (✓/✗)*
	(cont.)	f) Is tracking possible? How does tracking capability impact the system (such as performance over time, etc.) What additional system components are required for this capability?	
25.		***Confidence and Reliability*** a) What is the confidence factor attributed to the location data within the quoted time period for your technology? How does this factor vary with time? b) How does the accuracy and repeatability vary for different environments and state how the technology is influenced by external variables, such as multiple cell sites in city or rural areas, single cell configurations, multipath, hilly terrain, dense or urban areas, etc.? Will the accuracy or performance of the location technology depend on any elements of the wireless network, such as databases, the HLR or VLR? If so, what provision is expected to ensure consistency of information, particularly as the caller roams? c) What provision does your technology offer for redundancy, fail-safe or failure recovery? What mechanisms are provided for system monitoring?	
26.		***Coverage*** a) Describe the capability of your system to provide location coverage in both sparsely populated rural areas as well as dense urban environments. b) Can your technology offer both in-building and outside location ability? Does this capability provide tracking of a caller from inside to outside, and vice versa? c) How does the performance of the system change with varying outdoor (environmental) conditions? d) How does the performance vary in a fixed or mobile highway environment? Stationary, low speed vs. high speed? e) Comment on the impact on performance of your technology if the MST is contained in a persons pocket, in a purse or briefcase, or left laying on a seat in a vehicle. Include in your consideration the impact on handsfree capability, time to obtain initial location fix and location data acquisition on PSAP call back. f) How does the performance of the system behave with varying 911 traffic conditions? What limitations might you expect?	

Q #	Section Number	Question	Answered (✓/✗)
27.		***Standards/Multi-mode Capability*** a) Which standards, current and developing, most affect your system? b) Does your technology offer multi-mode compatibility? Which combinations? c) If not, when, ever? What CMRS technology does your system currently support?	
28.		***Implementation*** a) With regard to the wireless location technology you offer, what is the development status of the technology, particularly relative to each of the issues cited in section 9.1? b) What other important network architecture issues does your technology address that were not cited previously? c) What enabling technology developments are required to support your system? Who is developing them? What is their timing? d) What are the critical supporting technologies that must exist in the network to enable your technology? e) Using a chart such as that illustrated in Figure 9.2, map planned or expected developments over time. (Use a consistent scale of your choosing; however, please include an explanation.) f) Which areas of performance are considered important for future developments? Which do you consider key to selecting a location technology? g) If possible, describe the potential evolution path of your technology including improving performance over time. h) What trials, system testing have been undertaken? Are results available? i) What trials or testing have been undertaken in conjunction with a CMRS developer, service provider or network? Are results available? What further testing is planned? j) What other potential commercial benefits can your technology offer, or what other services will it enable?	
29.	9.3 *(cont.)*	***Technology Timelines*** a) What is the development status of the technology that you offer? b) How and when do you expect location accuracy to improve in the future? c) What development is required to realize your preferred level of integration? d) What is the timeframe for achieving that level of integration?	

Q #	*Section Number*	*Question*	*Answered (✓/✗)*
	(cont.)	e) What critical supporting developments are required to facilitate theimplementation of your technology (e.g., air-interfaces, standards, base stations, antennas, etc.)? f) What are the timelines relative to these supporting technologies? Who is developing these technologies? g) What is the migration path from where your technology is today to your preferred level of integration?	
30.	*9.4*	***Alternative solutions*** a) What other technologies exist that can provide a wireless location capability? b) What is the current development status of these technologies? Who is developing them? c) How do these technologies address each of the network impact issues described earlier? d) What will be the major impact on the network (i.e., mobile terminals, base stations, switches, etc.) of an alternative solution? What is required of the network to support an alternative location technology solution? e) What level of integration are alternative solutions capable of addressing now? f) What is the most probable/preferred level of integration as a future solution? What is the migration path to this preferred level of integration? g) What supporting technologies/systems are required to incorporate these alternative location technologies in a wireless E911 application? What is the status of their development? Who is developing these technologies? h) Can alternative solutions co-exist with network-based solutions?	
31.		***Alternative solution benefits*** Respondents are asked to comment on the above (alternative solutions). They should also consider the following: a) What is a likely migration strategy from one technology to another. b) Is there any benefit to multiple technology solutions? c) What would the impact of multiple technologies be on the network? d) What other services or commercial benefits can these alternative technologies support or enable?	

Q #	*Section Number*	*Question*	*Answered (✓/✗)*
32.	*9.5*	***Other Service Considerations*** Respondents are invited to give their views on the issues raised by the examples outlined. a) Are there other such examples? b) How important are these examples? Can the issues raised be ignored? When will they need to be addressed?	
33.		***Implementation*** Respondents are asked to comment on the possible inclusion of the examples in any implementation of location technology. a) What would be their impact on the choice of technology? b) Would they change the technology or network requirements with any significance? c) How might they be included? Short term versus later inclusion?	